

# **ELECTRICAL WORK**

## **OSHA STANDARD 29 CFR 1926.416**

OSHA requires that employees not work near any part of an electrical power circuit unless protected.

Per OSHA, "no employer shall permit an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against electric shock by de-energizing the circuit and grounding it or by guarding it effectively by insulation or other means."

In addition, all electrical work, installations and wire capacities shall be in done accordance with the requirements of the City's adopted Fire, Building and Electrical Codes and any applicable state and federal regulations.

### **GENERAL RULES:**

Only authorized employees shall be allowed to work on live circuits.

Only "qualified persons" shall be allowed to work on or near exposed energized parts. "Qualified" means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

Consider electric supply equipment and lines energized or "hot" unless known to be otherwise.

When an electrical circuit is open for repair, alteration or examination, the circuit shall be locked out, tagged and closed only by the one who opened the circuit or under the direction of the supervisor. Take special lock out precautions when the circuit may be energized by an automatic control device.

Circuit breakers will not be held or taped "on," nor will fuses be rigged.

All switches in a circuit breaker box shall be labeled and vacant switches shall be capped.

Use appropriate equipment around electricity.

All hand tools used for electrical work shall be of the insulated or non-conductive type.

- a. Do not use metal ladders for electrical work. OSHA requires portable ladders to have nonconductive side rails if used by an employee who is working where he or she might contact exposed energized circuit parts.
- b. Use extreme caution when engaged in work at a control switch box/cabinet. Wear approved rubber gloves until the lines are de-energized.
- d. Use an approved fiberglass disconnect rod/stick and rubber gloves when re-setting a disconnected fuse/blade.
- e. Wear safety toe shoes/boots or toe guards when handling poles, transformers or any other heavy objects.

Before starting work, determine existing conditions and know the operating voltage of equipment and lines.

Keep all mechanical equipment a minimum of 10 feet away from overhead power lines. If the voltage exceeds 50,000 volts, the clearance should be increased by four inches for each 10,000 volts.

Suitable danger signs shall be posted at all major electrical installations and high voltage areas.

Each outlet box must have a cover, faceplate or fixture canopy. Outlet box covers with holes for flexible cord pendants must have bushings designed for that purpose or smooth, well rounded surfaces to bear the cords.

## **Electrical Cords and Extension Cords**

Do not pull electric cords from their sockets by pulling or jerking the cord. To pull out, always grip the plug. Flexible cords must be connected to devices and fittings so that strain relief is provided. This must prevent pull from being directly sent to joints or terminal screws.

If an extension cord is needed, use a single one of suitable length, not a number of short ones.

Flexible cords may be used only in continuous lengths without splice or tap. Never use a series of short cords.

Only hard-service flexible cords No. 12 or larger may be repaired if properly spliced.

Always use three wire extension cords with portable tools.

Never cut off a ground prong on the plug of a three wire power cord.

Extension cords shall not be fastened by staples, hung by nails or suspended by wire.

Use three wire extension cords with portable tools.

Extension cords shall be protected against accidental damage caused by walking traffic, sharp corners, kinking and/or pinching.

Flexible cords and cables may **NOT** be used: as a substitute for the fixed wiring of a structure; where attached to building surfaces; where concealed or where run through holes in walls, ceilings or floors; or where run through doorways, windows or similar openings.

Retractable extension cords should be used where practical.

Re-locatable Power Taps ("power strips") shall **NOT** be used as an extension cord to one another or as a temporary wiring method (as prescribed by the City's adopted Fire, Building and Electrical Codes.)

## **Protection Against Electrical Hazards**

### **What is the best way to protect yourself against electrical hazards?**

Most electrical accidents result from one of the following three factors:

- unsafe equipment or installation,
- unsafe environment, or
- unsafe work practices.

Some ways to prevent these accidents are through the use of insulation, guarding, grounding, electrical protective devices, and safe work practices.

### **What protection does insulation provide?**

Insulators such as glass, mica, rubber, or plastic used to coat metals and other conductors help stop or reduce the flow of electrical current. This helps prevent shock, fires, and short circuits. To be effective, the insulation must be suitable for the voltage used and conditions such as temperature and other environmental factors like moisture, oil, gasoline, corrosive fumes, or other substances that could cause the insulator to fail.

### **How do you identify different types of insulation?**

Insulation on conductors is often color coded. Insulated equipment grounding conductors usually are either solid green or green with yellow stripes. Insulation covering grounded conductors is generally white or gray. Ungrounded conductors, or "hot wires," often are black or red, although they may be any color other than green, white, or gray.

Before connecting electrical equipment to a power source, it's a good idea to check the insulation for any exposed wires for possible defects. Insulation covering flexible cords such as extension cords is particularly vulnerable to damage.

The insulation that covers conductors in non-construction applications is regulated by Subpart S of 29 CFR 1910.302 through 1910.308, *Wiring Design and Protection*. Subpart S generally requires insulation on circuit conductors. It also specifies that the insulation used should be suitable for the voltage and conditions. Conductors used in construction applications are regulated by Subpart K of 29 CFR 1926.402 through 1926.408.

### **What is guarding and what protection does it offer?**

Guarding involves locating or enclosing electric equipment to make sure people don't accidentally come into contact with its live parts. Effective guarding requires equipment with exposed parts operating at 50 volts or more to be placed where it is accessible only to authorized people qualified to work with it. Recommended locations are a room, vault, or similar enclosure; a balcony, gallery, or elevated platform; or a site elevated 8 feet (2.44 meters) or more above the floor. Sturdy, permanent screens also can serve as effective guards.

Conspicuous signs must be posted at the entrances to electrical rooms and similarly guarded locations to alert people to the electrical hazard and to forbid entry to unauthorized people. Signs may contain the word "Danger," "Warning," or "Caution," and beneath that, appropriate concise wording that alerts people to the hazard or gives an instruction, such as "Danger/High Voltage/Keep Out."

### **What is grounding and what protection does it offer?**

"Grounding" a tool or electrical system means intentionally creating a low-resistance path that connects

to the earth. This prevents the buildup of voltages that could cause an electrical accident.

Grounding is normally a secondary protective measure to protect against electric shock. It does not guarantee that you won't get a shock or be injured or killed by an electrical current. It will, however, substantially reduce the risk, especially when used in combination with other safety measures discussed in this booklet.

29 CFR, Part 1910.304, Subpart S, Wiring Design and Protection, requires at times a service or system ground and an equipment ground in non-construction applications.

A *service or system ground* is designed primarily to protect machines, tools, and insulation against damage. One wire, called the "neutral" or "grounded" conductor, is grounded. In an ordinary low-voltage circuit, the white or gray wire is grounded at the generator or transformer and at the building's service entrance.

An *equipment ground* helps protect the equipment operator. It furnishes a second path for the current to pass through from the tool or machine to the ground. This additional ground safeguards the operator if a malfunction causes the tool's metal frame to become energized. The resulting flow of current may activate the circuit protection devices.

### **What are circuit protection devices and how do they work?**

Circuit protection devices limit or stop the flow of current automatically in the event of a ground fault, overload, or short circuit in the wiring system. Well-known examples of these devices are fuses, circuit breakers, ground-fault circuit interrupters, and arc-fault circuit interrupters.

*Fuses and circuit breakers* open or break the circuit automatically when too much current flows through them. When that happens, fuses melt and circuit breakers trip the circuit open. Fuses and circuit breakers are designed to protect conductors and equipment. They prevent wires and other components from overheating and open the circuit when there is a risk of a ground fault.

*Ground-fault circuit interrupters*, or GFCIs, are used in wet locations, construction sites, and other high-risk areas. These devices interrupt the flow of electricity within as little as 1/40 of a second to prevent electrocution. GFCIs compare the amount of current going into electric equipment with the amount of current returning from it along the circuit conductors. If the difference exceeds 5 milliamperes, the device automatically shuts off the electric power.

*Arc-fault devices* provide protection from the effects of arc-faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc-fault is detected.

### **What work practices help protect you against electrical hazards?**

Electrical accidents are largely preventable through safe work practices. Examples of these practices include the following:

- de-energizing electric equipment before inspection or repair,
- keeping electric tools properly maintained,
- exercising caution when working near energized lines, and
- using appropriate protective equipment.

Electrical safety-related work practice requirements for general industry are detailed in Subpart S of 29 CFR Part 1910, in Sections 1910.331–1910.335. For construction applications, electrical safety-related work practice requirements are detailed in Subpart K of 29 CFR Part 1926.416 to 1926.417.

### **How can you protect yourself against metal parts that become energized?**

A break in an electric tool's or machine's insulation can cause its metal parts to become "hot" or energized, meaning that they conduct electricity. Touching these energized parts can result in an electrical shock, burn, or electrocution. The best way to protect yourself when using electrical tools or machines is to establish a low-resistance path from the device's metallic case to the ground. This requires an equipment grounding conductor, a low-resistance wire that directs unwanted current directly to the ground. A properly installed grounding conductor has a low resistance to ground and greatly reduces the amount of current that passes through your body. Cord and plug equipment with a three-prong plug is a common example of equipment incorporating this ground conductor.

Another form of protection is to use listed or labeled portable tools and appliances protected by an approved system of double insulation or its equivalent. Where such a system is employed, it must be marked distinctively to indicate that the tool or appliance uses an approved double insulation system.

### **How can you prevent an accidental or unexpected equipment startup?**

Proper lockout/tagout procedures protect you from the dangers of the accidental or unexpected startup of electrical equipment and are required for general industry by OSHA Standard 1910.333, *Selection and Use of Work Practices*. Requirements for construction applications are in 29 CFR 1926.417, *Lockout and Tagging of Circuits*. These procedures ensure that electrical equipment is de-energized before it is repaired or inspected and protects you against electrocution or shock.

The first step before beginning any inspection or repair job is to turn the current off at the switch box and padlock the switch in the OFF position. This applies even on so-called low-voltage circuits. Securely tagging the switch or controls of the machine or equipment being locked out of service clarifies to everyone in the area which equipment or circuits are being inspected or repaired.

Only qualified electricians who have been trained in safe lockout procedures should maintain electrical equipment. No two of the locks used should match, and each key should fit just one lock. In addition, one individual lock and key should be issued to each maintenance worker authorized to lock out and tag the equipment. All employees who repair a given piece of equipment should lock out its switch with an individual lock. Only authorized workers should be permitted to remove it.

### **How can you protect yourself from overhead power lines?**

Before working under or near overhead power lines, ensure that you maintain a safe distance to the lines and, for very high-voltage lines, ground any equipment such as cranes that can become energized. If working on power lines, ensure that the lines have been de-energized and grounded by the owner or operator of the lines. Other protective measures like guarding or insulating the lines help prevent accidental contact.

Employees unqualified to work with electricity, as well as mechanical equipment, should remain at least 10 feet (3.05 meters) away from overhead power lines. If the voltage is more than 50,000 volts, the clearance increases by 4 inches (10 centimeters) for each additional 10,000 volts.

When mechanical equipment is operated near overhead lines, employees standing on the ground should avoid contact with the equipment unless it is located outside the danger zone. When factoring the safe standoff distance, be sure to consider the equipment's maximum reach.

### **What protection does personal equipment offer?**

Employees who work directly with electricity should use the personal protective equipment required for the jobs they perform. This equipment may include rubber insulating gloves, hoods, sleeves, matting, blankets, line hose, and industrial protective helmets designed to reduce electric shock hazard. All help reduce the risk of electrical accidents.

### **What role do tools play?**

Appropriate and properly maintained tools help protect workers against electric hazards. It's important to maintain tools regularly because it prevents them from deteriorating and becoming dangerous. Check each tool before using it. If you find a defect, immediately remove it from service and tag it so no one will use it until it has been repaired or replaced.

When using a tool to handle energized conductors, check to make sure it is designed and constructed to withstand the voltages and stresses to which it has been exposed.

### **What special training do employees need?**

All employees should be trained to be thoroughly familiar with the safety procedures for their particular jobs. Moreover, good judgment and common sense are integral to preventing electrical accidents. When working on electrical equipment, for example, some basic procedures to follow are to:

- de-energize the equipment,
- use lockout and tag procedures to ensure that the equipment remains de-energized,
- use insulating protective equipment, and
- maintain a safe distance from energized parts.

### **What's the value of a safety and health program in controlling electrical hazards?**

Every good safety and health program provides measures to control electrical hazards. The measures suggested in this booklet should be helpful in establishing such a program. The responsibility for this program should be delegated to someone with a complete knowledge of electricity, electrical work practices, and the appropriate OSHA standards for installation and performance.

Everyone has the right to work in a safe environment. Safety and health add value to your business and your workplace. Through cooperative efforts, employers and employees can learn to identify and eliminate or control electrical hazards.

# OSHA FactSheet

## Working Safely with Electricity

Working with electricity can be dangerous. Engineers, linemen, electricians, and others work with electricity directly, including overhead lines, cable harnesses, and circuit assemblies. Office workers and salespeople work with electricity indirectly and may also be exposed to electrical hazards.

### Generators

One of the common tools utilized following the loss of power are portable generators. Most generators are gasoline powered and use internal combustion engines to produce electricity. Carbon monoxide is a colorless and odorless gas produced during the operation of gasoline powered generators. When inhaled, the gas reduces your ability to utilize oxygen. Symptoms of carbon monoxide poisoning include headache, nausea and tiredness that can lead to unconsciousness and ultimately prove fatal.

- DO NOT bring a generator indoors. Be sure it is located outdoors in a location where the exhaust gases cannot enter a home or building. Good ventilation is the key.
- Be sure that the main circuit breaker is OFF and locked out prior to starting any generator. This will prevent inadvertent energization of power lines from back feed electrical energy from generators and help protect utility line workers from possible electrocution.
- Turn off generators and let them cool prior to refueling.

### Power Lines

Overhead and buried power lines are especially hazardous because they carry extremely high voltage. Fatal electrocution is the main risk, but burns and falls are also hazards.

- Look for overhead power lines and buried power line indicators.
- Stay at least 10 feet away from overhead power lines and assume they are energized.
- De-energize and ground lines when working near them.
- Use non-conductive wood or fiberglass ladders when working near power lines.

### Extension Cords

Normal wear on cords can loosen or expose wires. Cords that are not 3-wire type, not designed for hard-usage, or that have been modified, increase your risk of contacting electrical current.

- Use only equipment that is approved to meet OSHA standards.
- Do not modify cords or use them incorrectly.
- Use factory-assembled cord sets and only extension cords that are 3-wire type.
- Use only cords, connection devices, and fittings that are equipped with strain relief.
- Remove cords from receptacles by pulling on the plugs, not the cords.

### Equipment

Due to the dynamic, rugged nature of construction work, normal use of electrical equipment causes wear and tear that results in insulation breaks, short-circuits, and exposed wires. If there is no ground-fault protection, it can cause a ground-fault that sends current through the worker's body.

- Use ground-fault circuit interrupters (GFCIs) on all 120-volt, single-phase, 15- and 20-ampere receptacles, or have an assured equipment grounding conductor program (AEGCP).
- Use double-insulated tools and equipment, distinctively marked.
- Visually inspect all electrical equipment before use. Remove from service any equipment with frayed cords, missing ground prongs, cracked tool casings, etc.

### Electrical Incidents

If the power supply to the electrical equipment is not grounded or the path has been broken, fault

current may travel through a worker's body, causing electrical burns or death. Even when the power system is properly grounded, electrical equipment can instantly change from safe to hazardous because of extreme conditions and rough treatment.

- Visually inspect electrical equipment before use. Take any defective equipment out of service.
- Ground all power supply systems, electrical circuits, and electrical equipment.

- Frequently inspect electrical systems to insure that the path to ground is continuous.
- Do not remove ground prongs from cord- and plug-connected equipment or extension cords.
- Use double-insulated tools and ground all exposed metal parts of equipment.
- Avoid standing in wet areas when using portable electrical power tools.

**This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.**

**Think Safety!**

For more complete information:



U.S. Department of Labor

**[www.osha.gov](http://www.osha.gov)**

**(800) 321-OSHA**